

Air Force Space Command

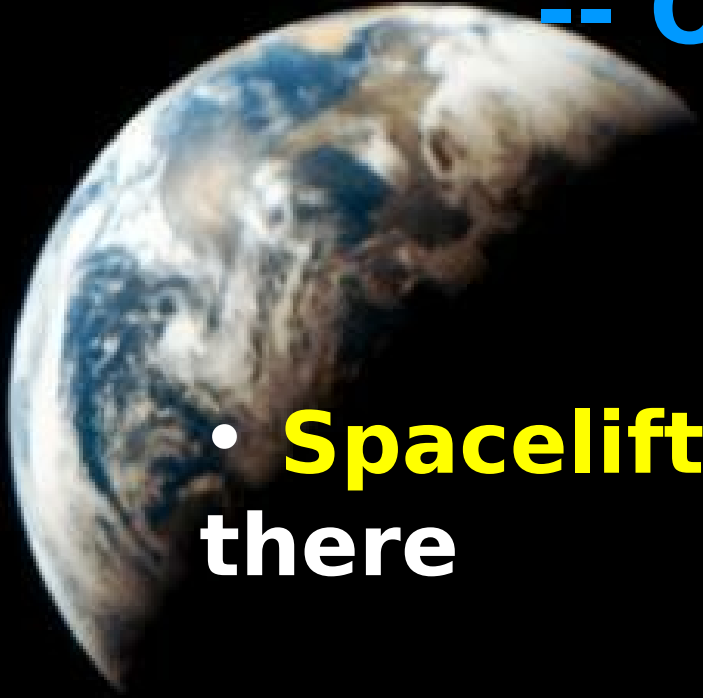


Space Missions In Today's Air Force

**Colonel John L. Wilkinson
Headquarters, AF Space Command
Peterson AFB, Colorado**

Air Force Space Missions

-- Overview --



- **Spacelift** – what it takes to get there
- **Orbital Mechanics** – a “crash course”!
- **Space Missions** – once you are there

Air Force Space Missions

Giving Credit First!



Sir Isaac Newton

- **Sir Isaac Newton**
1643-1727, London, England
 - Laws of Motion
 - Universal Law of Gravity
- **Johannes Kepler**
1571-1630, Regensburg, Germany
 - Three Laws of Planetary Motion



Johannes Kepler

**Newton & Kepler's study of our Universe
Laid the Foundation of Orbital Mechanics**



Space Missions

the key message ..



- You must attain great speed to get and stay in orbit
- There are many orbit types for different missions
- It takes a team to operate space missions

Spacelift

- **The speed required to attain orbit**

....

- **Orbital Velocity = > 17,500 MPH**
- **Escape Velocity = > 25,000 MPH**
- **Rockets with that power!**



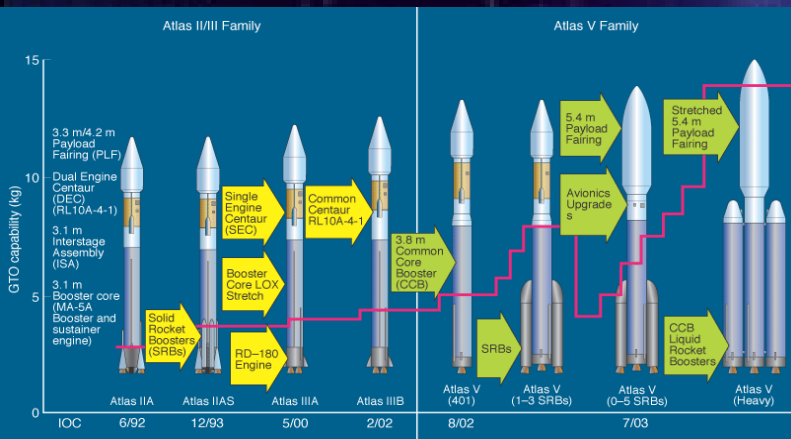
Evolved Expendable Launch Vehicle

New Rocket Brand

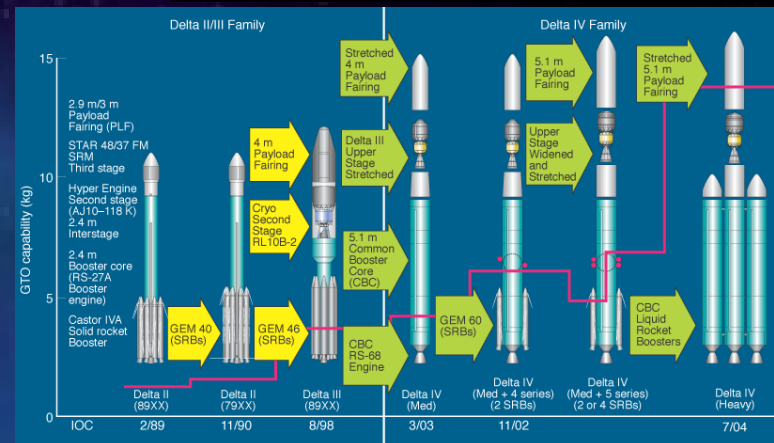
- EELV partners Air Force with Industry
- New rockets use common components
- EELV reduces space launch costs
- Creates more reliable launch systems



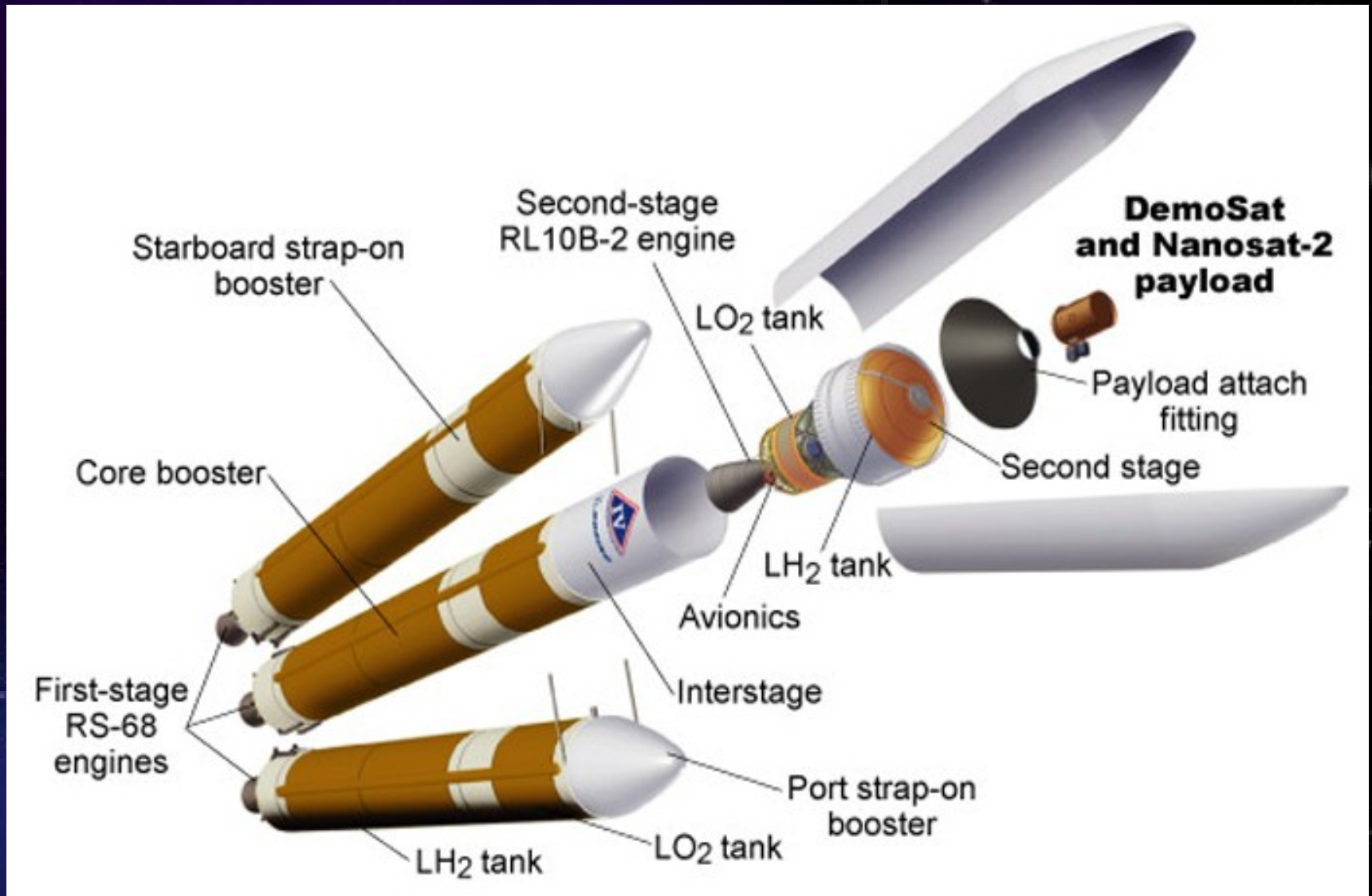
Lockheed Martin Corporation



Boeing Corporation



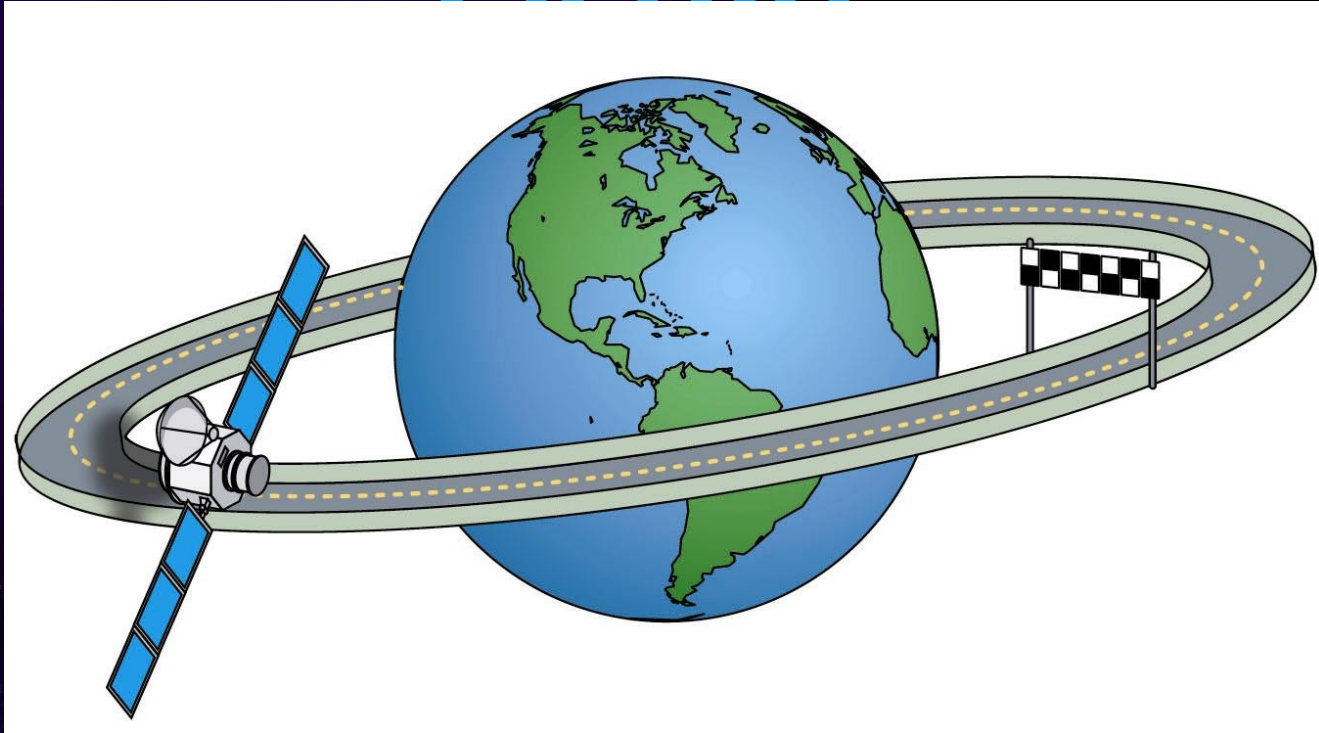
The Delta IV Rocket



The Delta IV Rocket Satellite Launch to Orbit

Launch Video

Orbits - The Big Picture



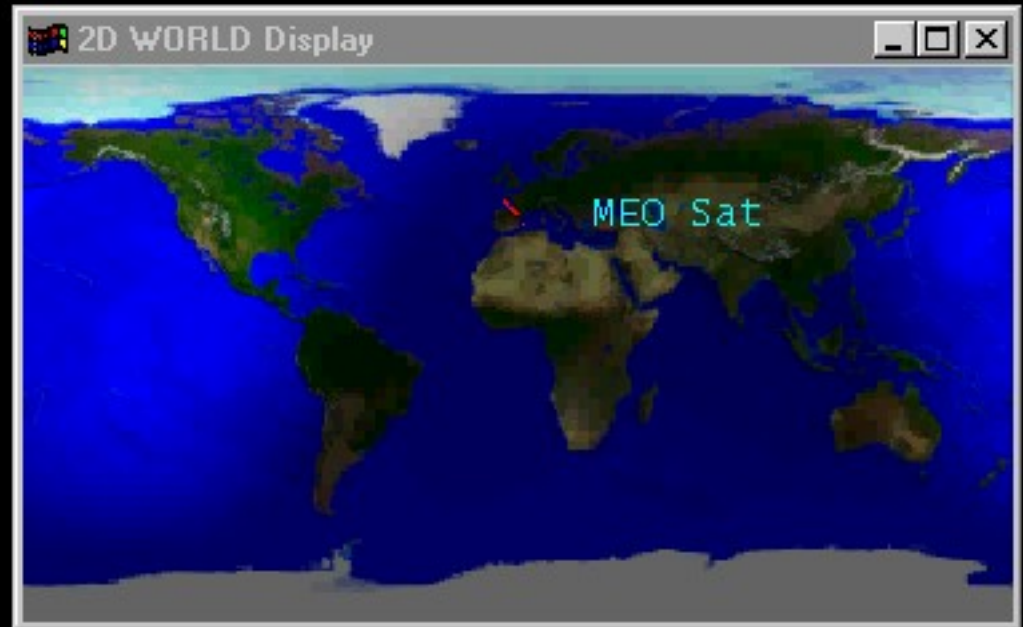
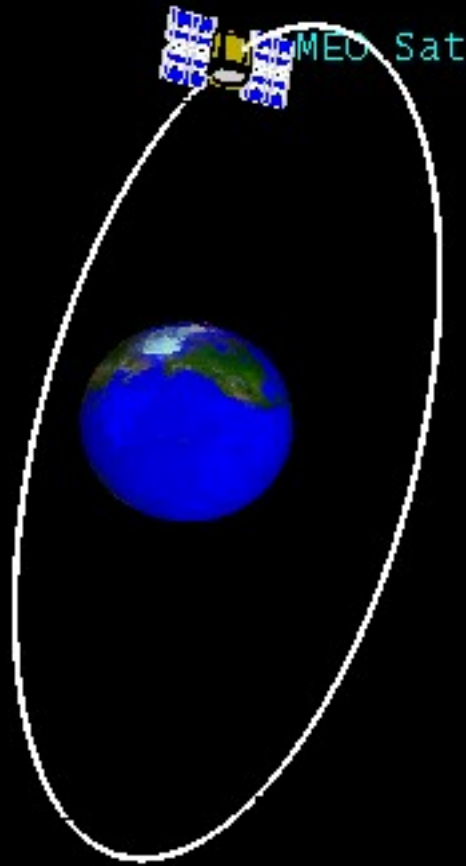
- Orbits are “**racetracks**” that satellites “drive” around Earth
- A satellite’s **orbit is fixed in space**
- The **Earth** rotates under the orbit
- But the satellite’s **orbital plane** stays fixed

Low Earth Orbit (LEO)



Period: 90 Minutes Altitude: Up to 1000 miles
But Small View of Earth's surface
Smaller rocket + Less fuel = Lower launch cost

Semi-Synchronous Orbit (MEO)



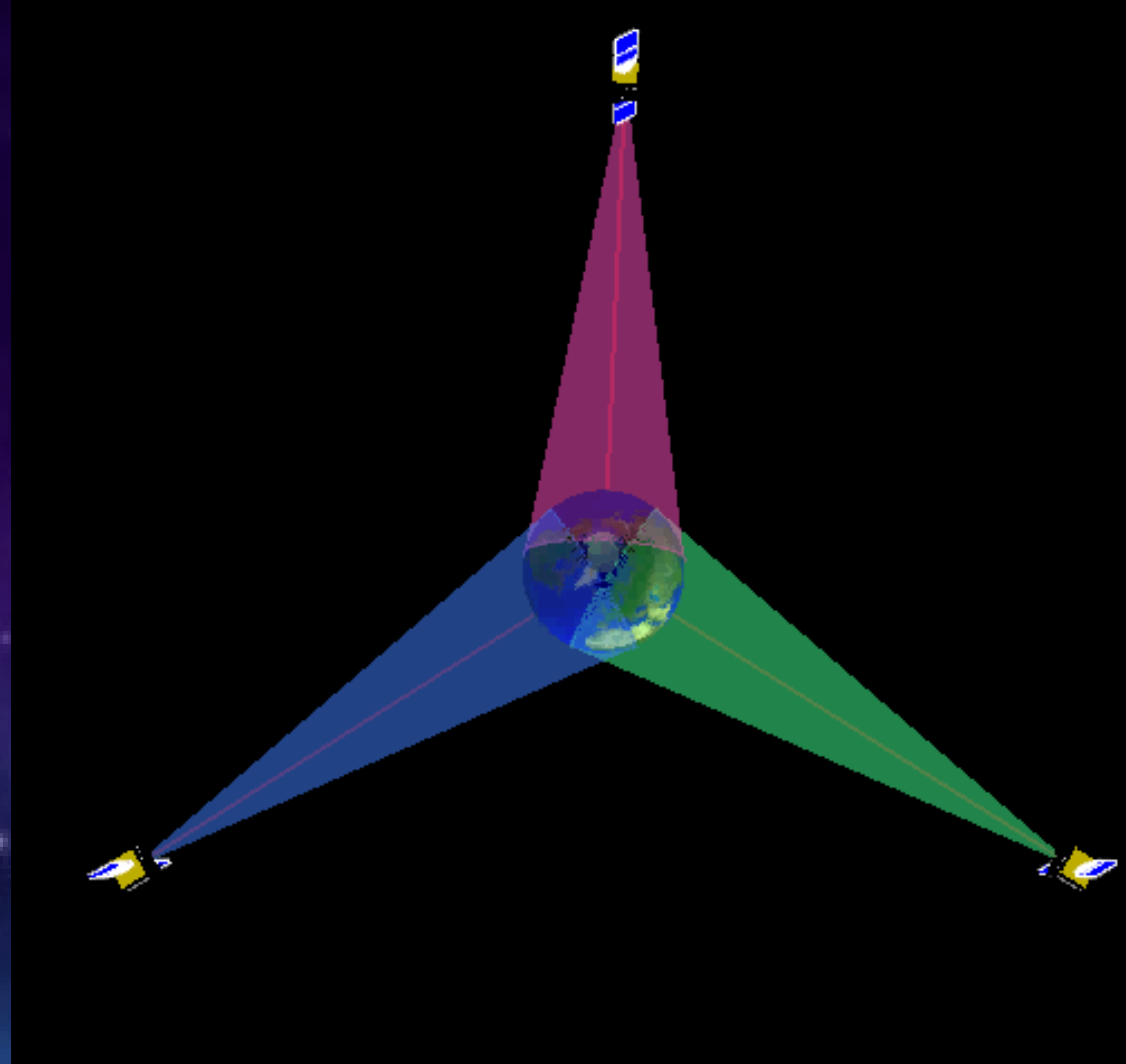
Period: 12 Hours
12,500 miles

Altitude:

Larger View of Earth's surface

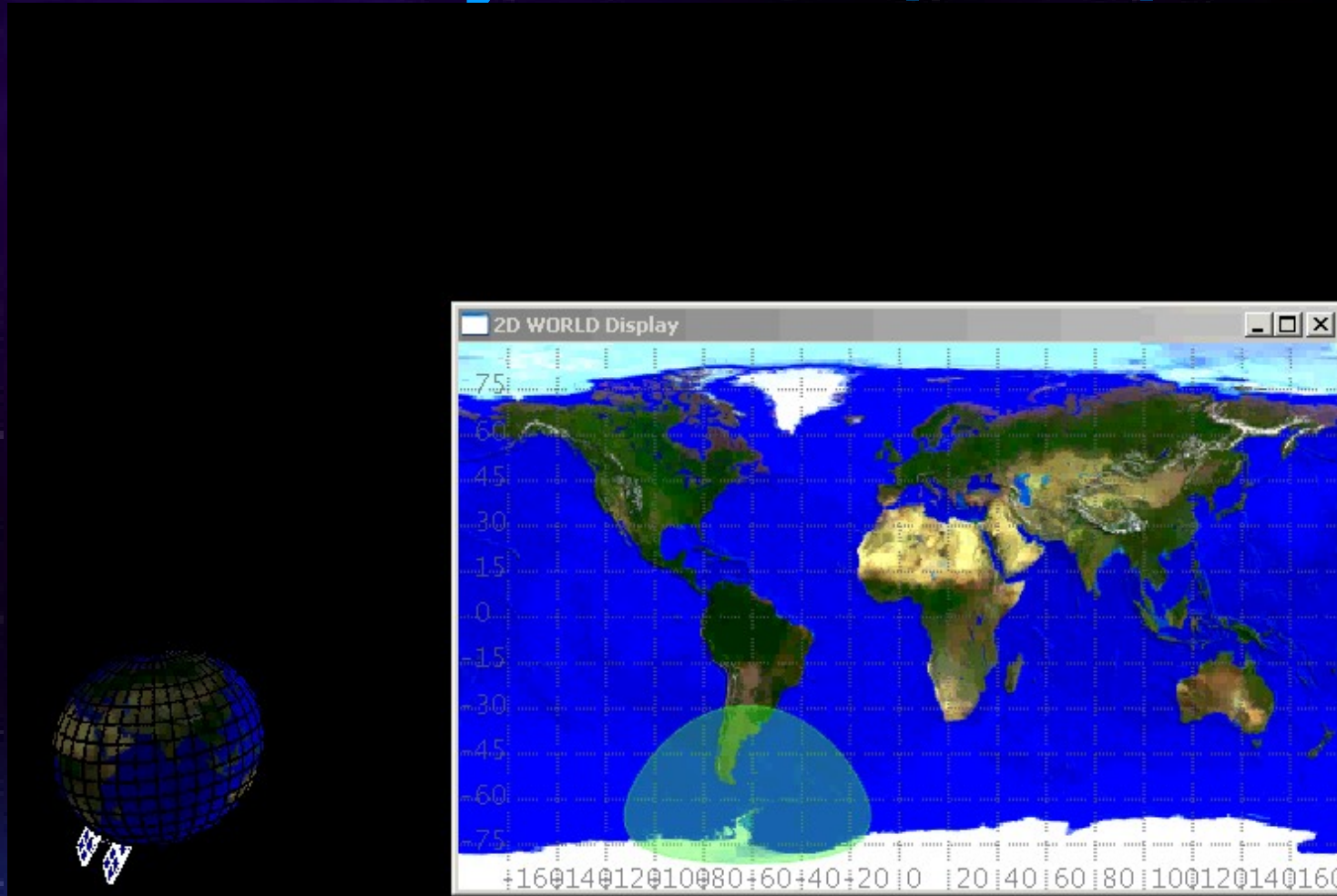
Geosynchronous Orbit (GEO)

- **Period:** 24 hours
- **Altitude:** 22,500 miles
- Constant Earth view
- 3 satellites covers the world (except for north & south poles)



Large rocket + Most fuel = Expensive Launch

Molniya Orbit (HEO)

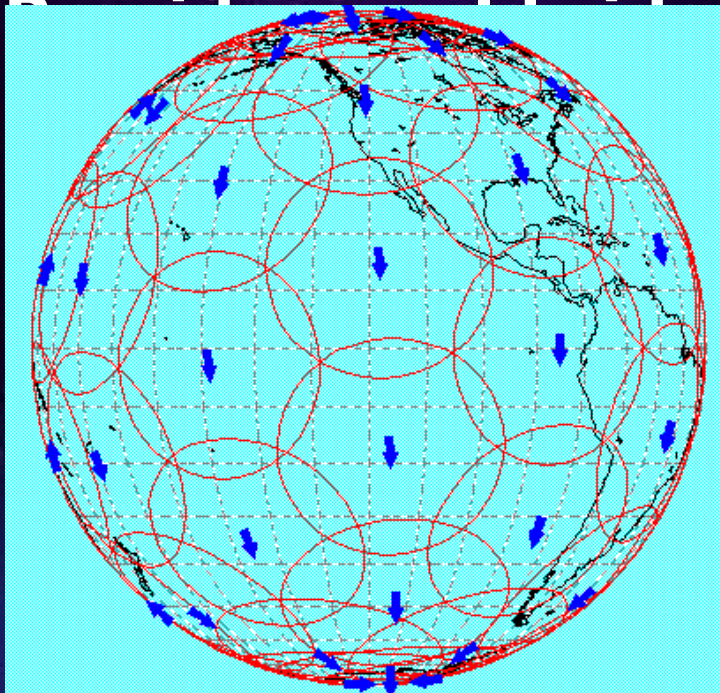


- **Maximum coverage at higher latitudes**
- **Long apogee dwell-time - 8 hours of a 12 hour orbit**
- **HEO orbit covers the gaps of a GEO**

Satellite Constellations

When it takes many satellites to do the job!

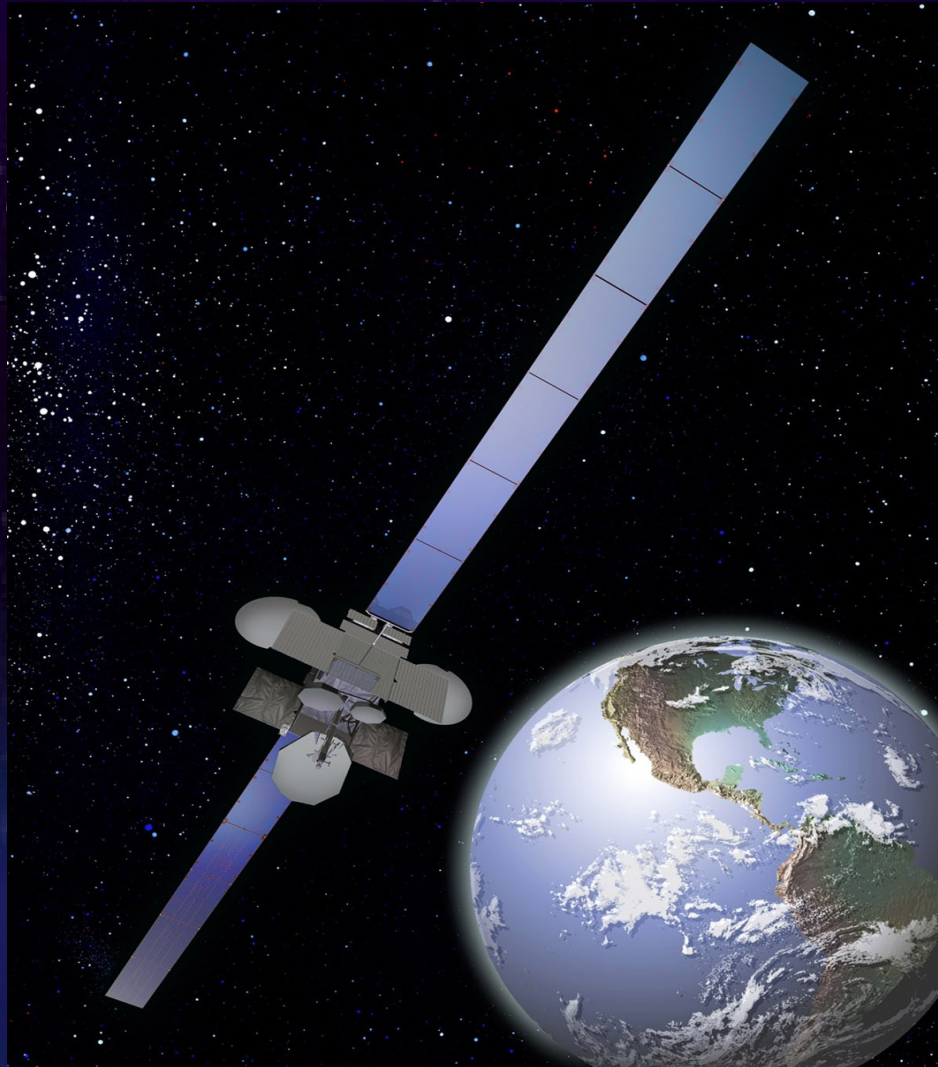
- Iridium – First LEO Satellite communications system
- 80 satellite constellation (plus 14 spares)
- Provides global cellular coverage



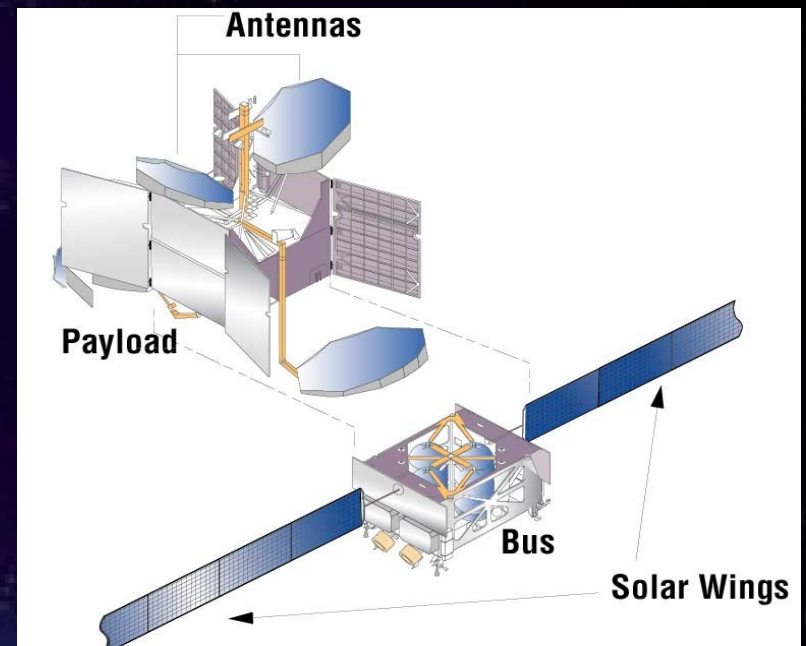
Iridium Low Earth Orbit Constellation

Space Missions

Operating Satellites on Orbit



Boeing 702 Expanded View



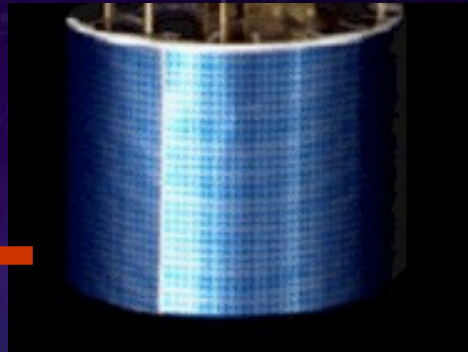
Deployed length	41.4 m
Stowed dimensions	2 m x 3.2 m x 3.7 m
Payload mass (up to 118 transponders)	1200 kg
Launch mass	5200 kg
Xenon ion propulsion system (XIPS)	Used for N/S stationkeeping
Dual and triple junction GaAs solar cells with concentrator	up to 25 kw

Basic Elements of a Satellite



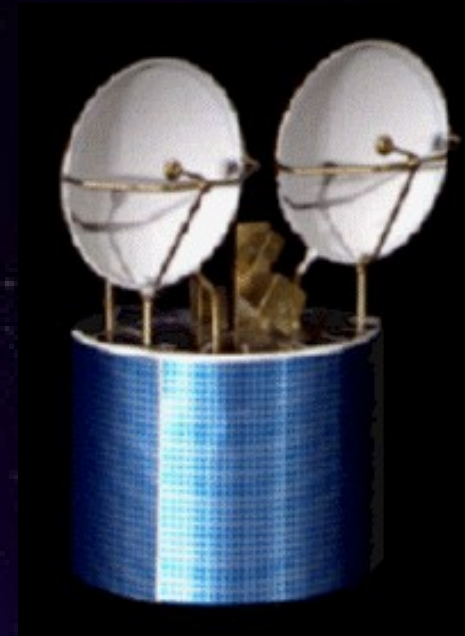
Payload

+



**Vehicle
or
“Bus”**

=



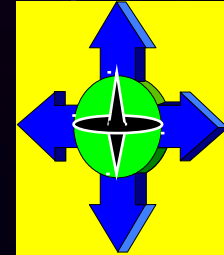
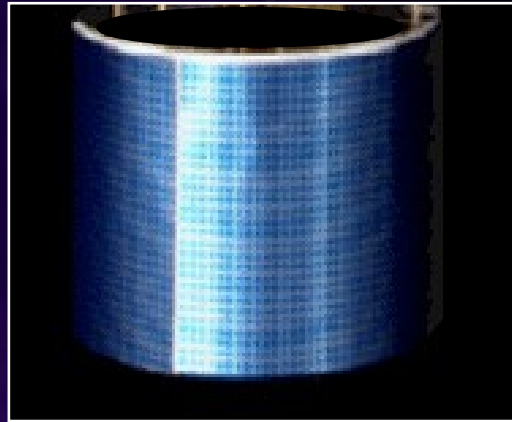
Satellite

Satellite Subsystems



Navigation, Guidance and Control

To safely maneuver in
space



Attitude Determination and Control

To control positioning



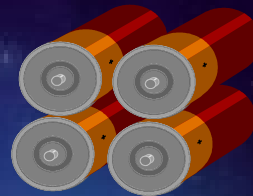
Structural

To Protect the
Satellite



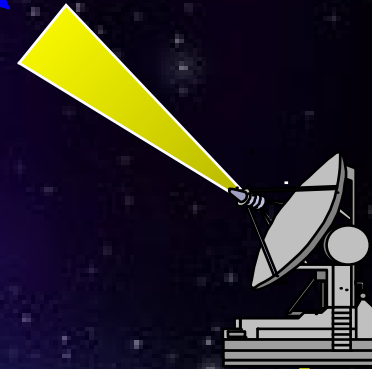
Thermal

Heating &
Cooling



Power

To Operate
in Space



Communications

To Operate the
Satellite

Operating Satellites on Orbit

It takes a Team!

- Performed by teams of people located on the ground and in space
- Requires ground antennas, computer hardware and software to communicate



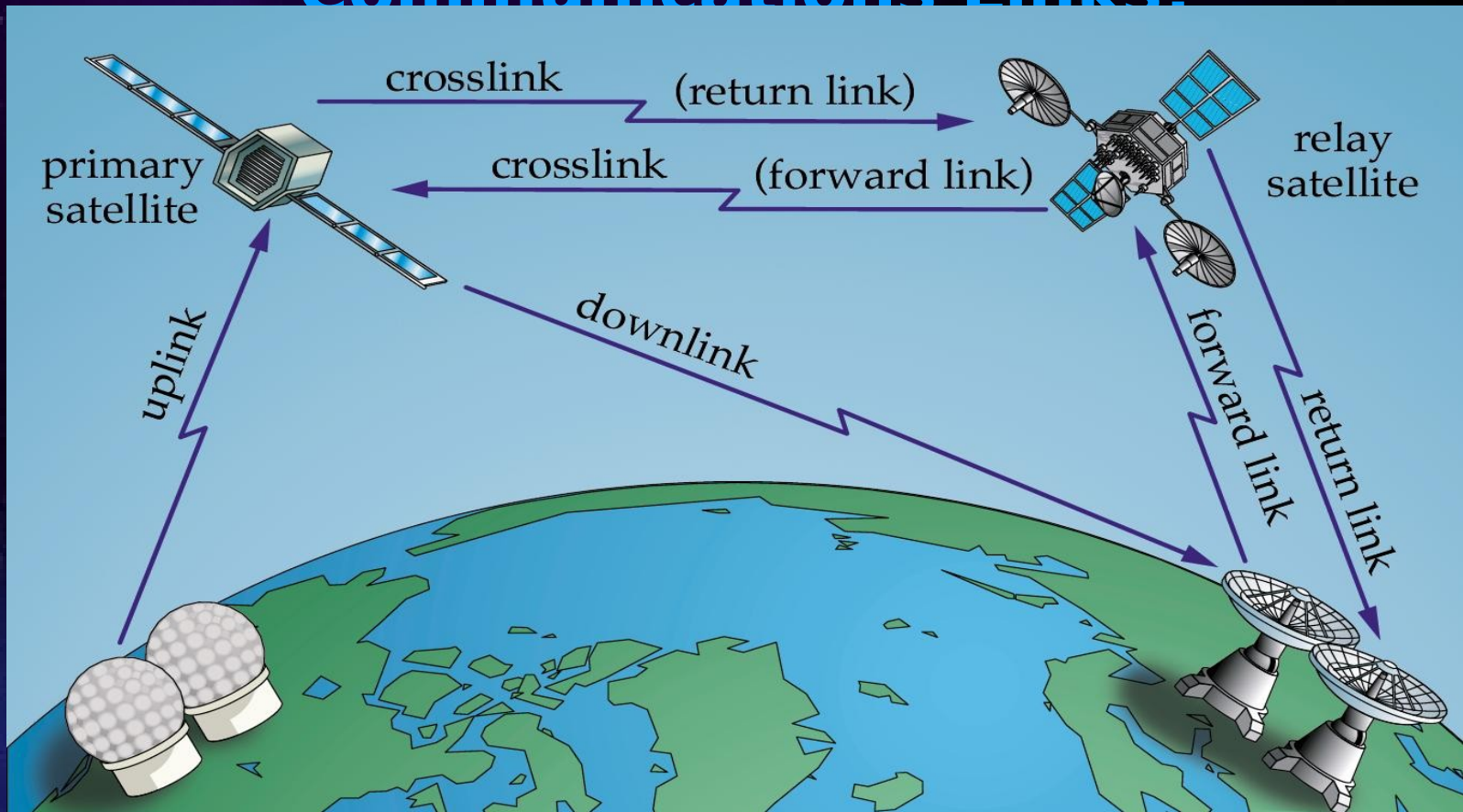
Apollo Mission Control Center
US: Fig. 1-32



Surrey Ops Center US:
Fig. 1-33

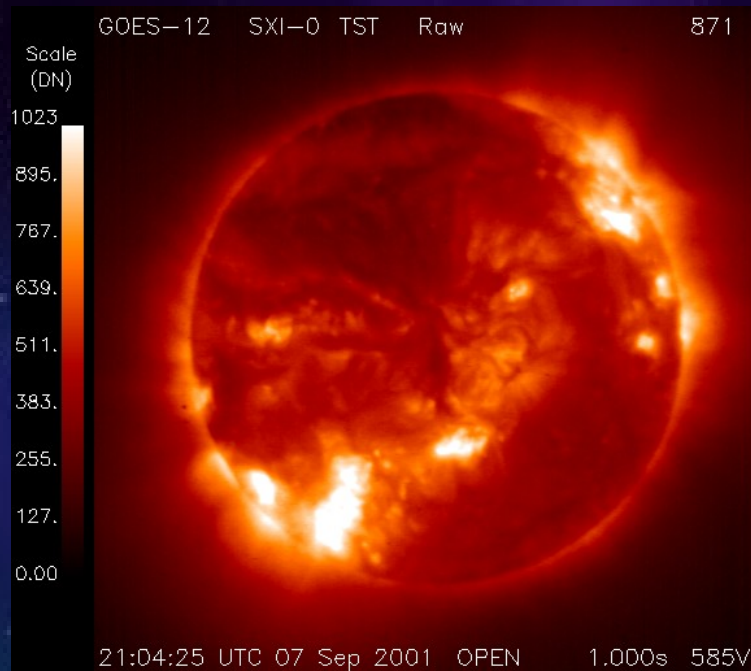
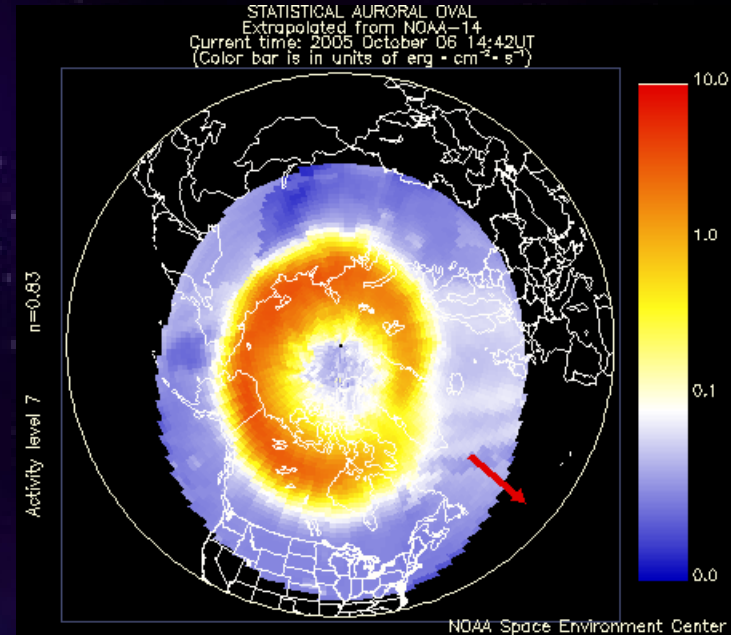
Operating Satellite Constellations

You need Ground Processing and Communications Links!



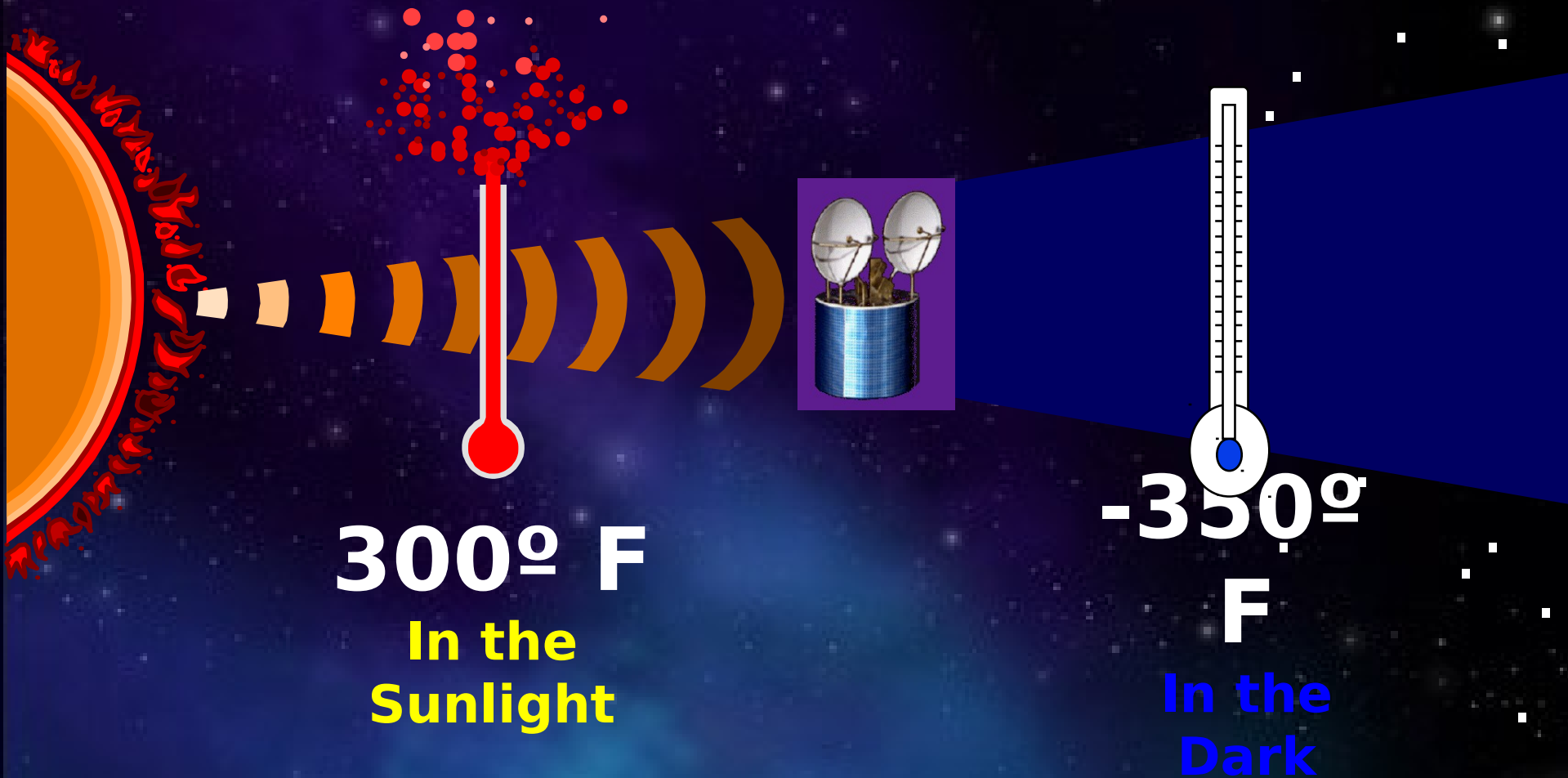
The Space Environment

A Tough Place to Operate!



The Space Environment

Protecting from Extreme Heat and Cold



The Space Environment

Using Batteries when there's no Sunlight



Orbital Maneuvers

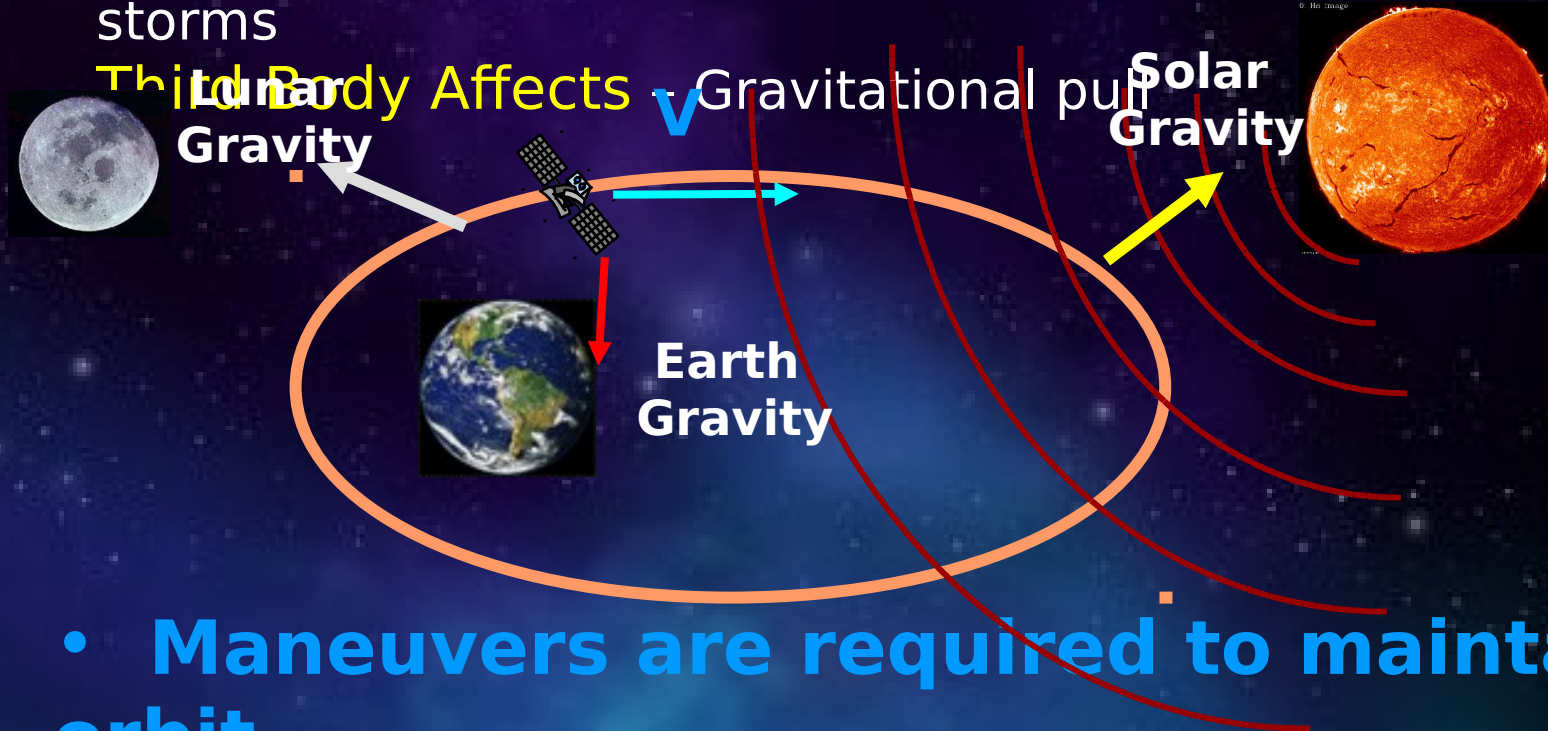
- Perturbations alter an Orbit:**

Atmospheric Drag – “Scraping” the Earth’s atmosphere

Earth Oblateness -- Causes north/south wandering of GEO satellites

Solar Effects – Radiation, particle discharge, geo-magnetic storms

Third Body Affects – Gravitational pull



- Maneuvers are required to maintain an orbit**

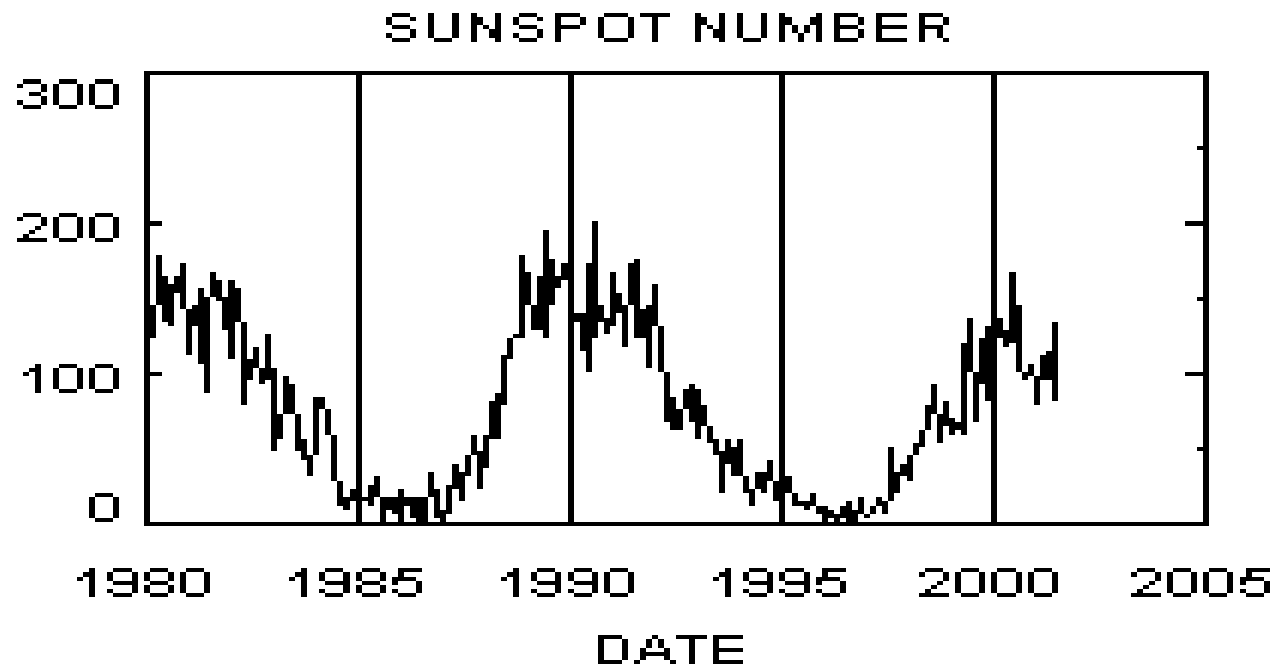
Solar Physics



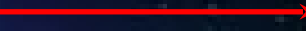
Science Directorate
Marshall Space Flight Center



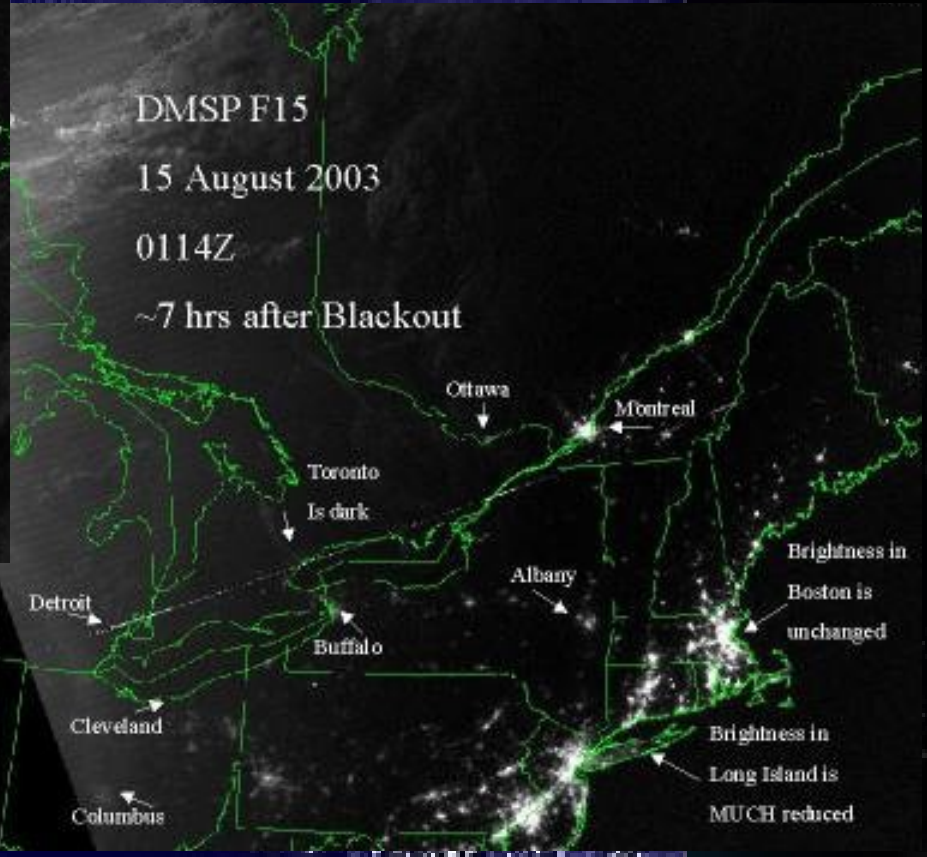
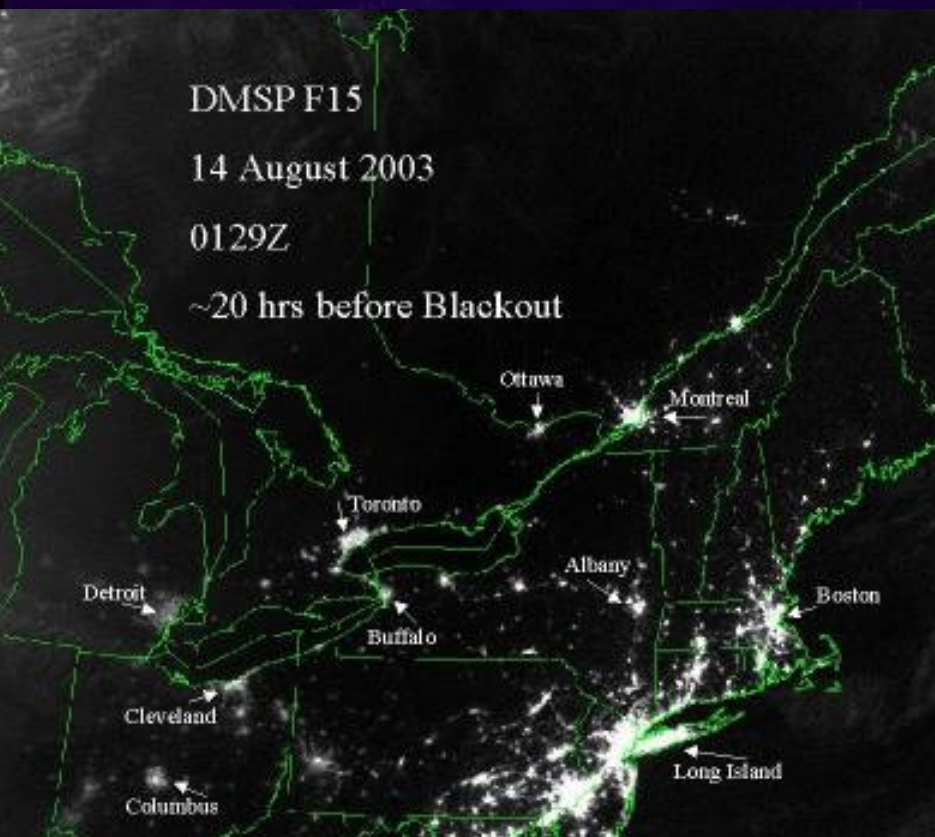
Number
Of
sunspots



10-Year "Solar Max" Cycle



Blackout Caused by our Sun!



ISAT GeoStar 45
23:15 EST 14 Aug. 2003

Space Missions We Perform



Spacelift and Satellite Operations

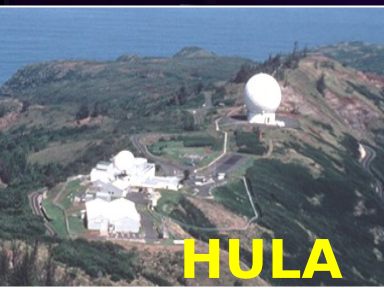
We operate the

- **Spacelift Ranges - Safe Rocket Launching**

- **AF Satellite Control Network - Flying Satellites**

Remote Tracking Stations are Worldwide

Hawaii



HULA

REEF

California



COOK

Colorado



PIKE

New Hampshire



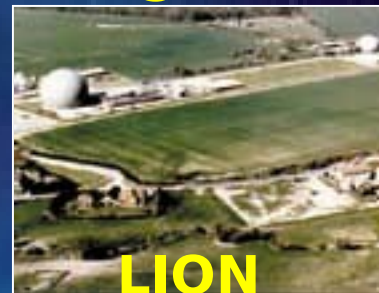
BOSS

Thule, Greenland



POGO

England



LION

Diego Garcia



Guam



Space Surveillance

- **Space debris is a major challenge!**

Country of Origin

United States			
Russia (& FSU)			
ESA	33	2	30
Japan	78	5	
China	35	0	
France			
Other	<u>414</u>	<u>5</u>	
	Total		



,814

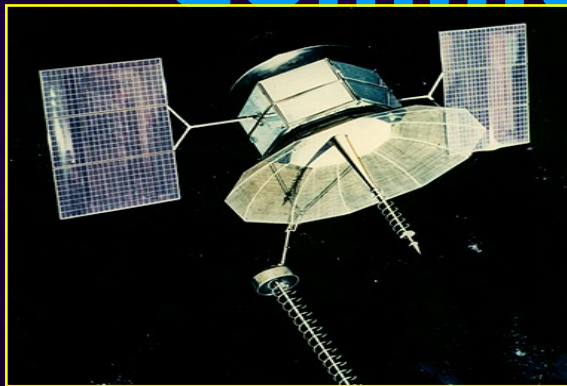
13

6,136

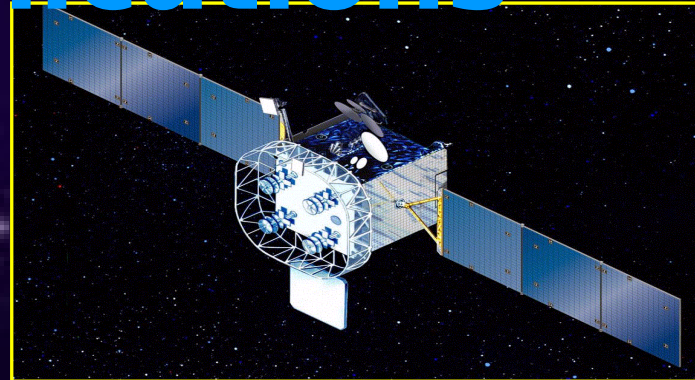
objects

- **Total Payloads, Spa**
- **Space Surveillance Network** - helps keeps space safe
 - Worldwide sensors track and catalog all objects in space
 - Allows safe satellite operations & prevents collisions

Military Satellite Communications



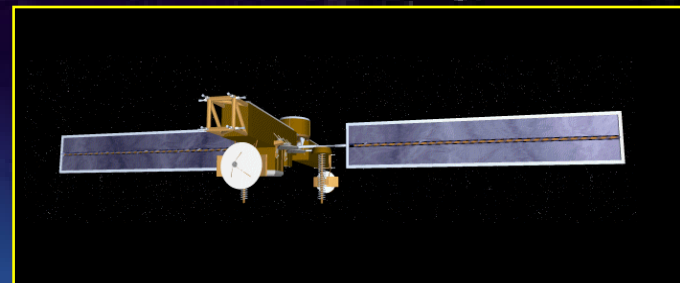
FLTSATCOM



UHF Follow-On



DSCS

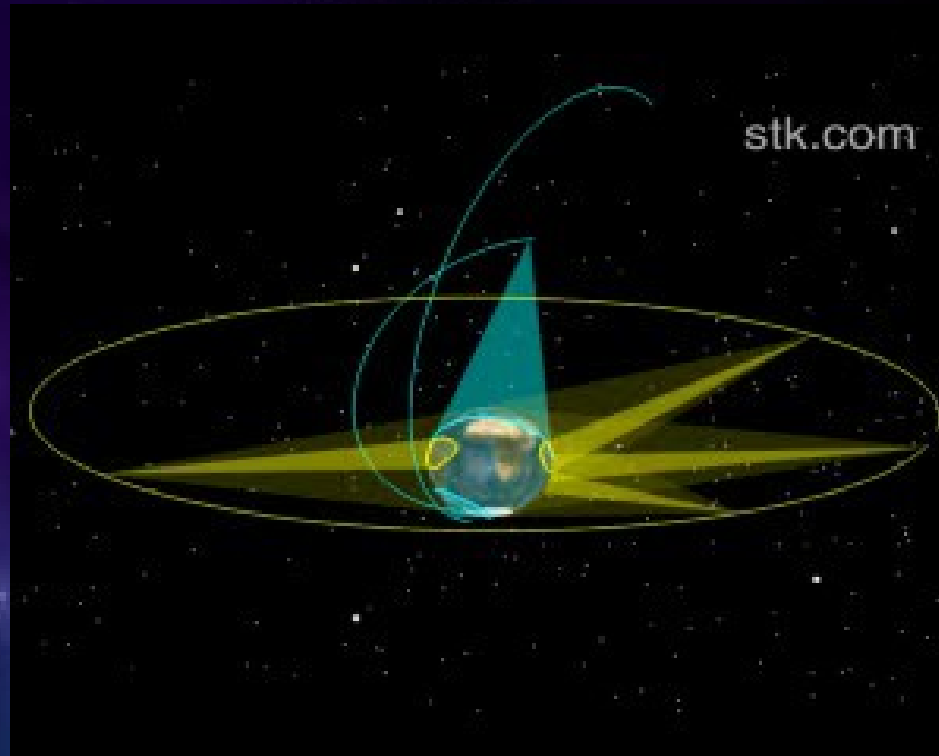


MILSTAR

**Communicating with worldwide military forces
Satellites in Geostationary Orbits**

Missile Warning

- **Defense Support Program satellites detect heat from missile and booster plumes around the world**



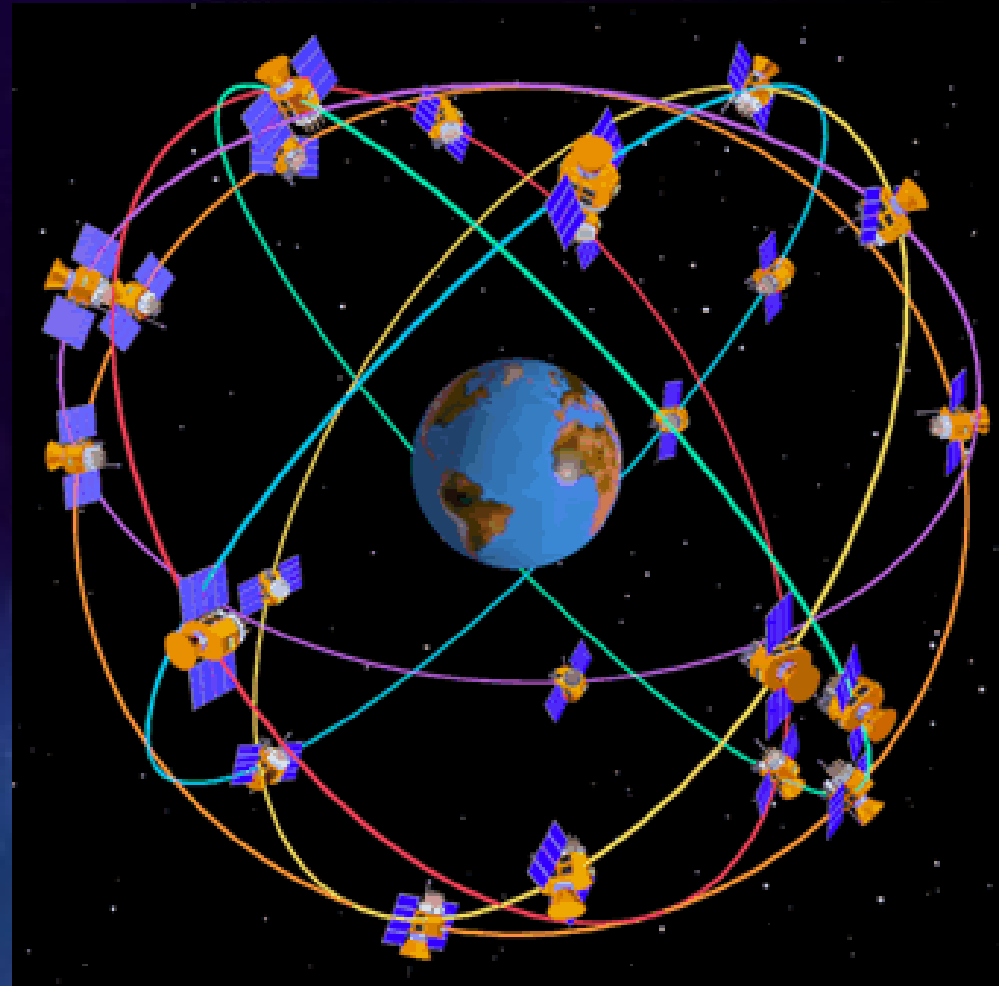
- **Missile Warning Crews provide warning of missile attacks launched against North**

Global Positioning System



GPS CONSTELLATION

- Precise worldwide position, speed, and time
- 6 orbital planes
- 4 satellites in each plane
- 24 satellite constellation
- Medium Earth Orbit (12,500 miles from



Weather Environment

- **Defense Meteorological Support Program (DMSP)**

Tracking Earth's weather



GOES satellite image



- **Geostationary Operational Environmental Satellite (GOES)**
 - Integrated with radar
 - Can precisely track thunderstorms, tornadoes, hurricanes and winter storms



AF Space Command Missions

- **We are the world's premier Air and Space Power**
- **We operate & maintain worldwide satellites and sensors for warfighters around the world**
- **It takes a Team - and you could be part!**

USAF Space Command



***Space Power
for the 21st
Century***